JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 16 JANUARY 19, 1926 No. 2

GEODESY.—*The deflection of the vertical in Porto Rico.* WILLIAM BOWIE, U. S. Coast and Geodetic Survey.

Island masses furnish numerous cases of large deflections of the vertical by which the distribution of densities in the earth's crust may be studied. A notable case is in the island of Porto Rico in the West Indies. Astronomic latitude stations on the south and the north coasts are connected by triangulation. The difference in the astronomic latitudes is 35′ 36″.00 while the difference in the latitude of the astronomic stations as derived from the distance between them obtained by triangulation is 34′ 40″.20. The difference between these two values is 55″.80, or about one statute mile. This value is the relative deflection of the vertical. Since the plumb line at each of the stations is attracted by the island mass and repelled by the deficiency of mass in the space occupied by water in the Atlantic Ocean or in the Caribbean Sea, it is certain the direction of the plumb line at each station is affected.

TABLE 1.—ISOSTATIC REDUCTIONS OF TWO STATIONS IN PORTO RICO

STATION	EFFECT OF TOPOGRAPHY ALONE	EFFECT OF TOPOGRAPHY AND COMPENSATION TO DEPTHS OF			
		96 km.	120.9 km.	162.2 km.	231.3 km.
	seconds	*seconds*	*seconds*	*seconds*	*seconds*
Muertos Island Light House on south coast	−0.65	−18.83	−20.84	−22.92	−24.65
San Juan Light House on north coast.	+74.63	+20.37	+23.26	+26.93	+31.35
Combined effect at the two stations.	75.28	39.20	44.10	49.85	56.00

The isostatic reductions of the two latitude stations were made by Messrs. C. H. Swick and W. D. Lambert of the Coast and Geodetic Survey with the results shown in table 1.

The densities below the surface of the island are not known, and, of

course, there is no way of learning by direct means the density of the crust under the water surrounding Porto Rico. In the computations the density of the mass above sea level was taken as 2.67, this being the value adopted and used in the isostatic reductions by the U. S. Coast and Geodetic Survey.

The most probable depth of compensation resulting from isostatic investigation by that Bureau is 96 kilometers. But with that depth, applied to Porto Rico, the effect of topography and compensation is only 39″.20, or 16″.60 less than the relative deflection of the vertical between the two stations.

If the astronomic work and the triangulation were perfect, the crust in perfect isostatic equilibrium, the density conditions as used in the computations true and no errors exist in map readings, then the depth to which the compensation is distributed under and around the island would be about 230 kilometers. The combined topographic and compensation effect for the two stations is 56″.00 for the depth 231.3 kilometers, used in the computations.

Since the computed deflection to the south for the San Juan station, and that to the north for the Muertos station are too small to account for the observed combined deflection, we must conclude that there is something abnormal about the Porto Rico region. It does not seem to be probable that the depth of compensation in the region is as much as 230 kilometers. This is nearly two and one-half times the depth derived for the area of the United States. The astronomic work is believed to be very accurate, while the distances by triangulation are correct. There is no detailed topographic map of the island, nor are the depths of the surrounding waters given in much detail. Some error in the computed effects may be due to erroneous map and chart data, but probably not very much. No definite conclusions are possible as to the cause of the Porto Rican deflection remaining after the corrections for topography and compensation have been applied.

The density of the materials of the crust to the north and to the south of the island seems to be too low. That is, the normal density of the crust augmented by the compensation distributed to a depth of 96 kilometers is greater than the excess of deflection indicates to be the case. Or it may be that the crust under the water areas is normal in density, but that the upper crust under the island is excessively dense.

If the compensation of the island material is regionally distributed horizontally throughout the pedestal on which the island stands, the effect of the compensation of the island would be such as to increase the

deflection of the plumb line at the two stations toward the island, thus making for closer agreement between the computed and observed deflections.

While the application of the isostatic method with a depth of 96 kilometers leaves a residual of 16″.60, and with depth of 120.9 kilometers a residual of 11″.70, the residual found by applying the effect of topography alone is 19″.48. All of these residuals are of the same order of magnitude.

It would seem that the region around Porto Rico, if in isostatic adjustment and if densities are otherwise normal, has a great depth of compensation or, if in isostatic equilibrium at depth of about 100 kilometers, there is very irregular distribution of densities near the surface under the island and also under the adjacent water areas. The other condition might be absence of isostatic equilibrium of the region, but with isostasy applied the computed deflection is smaller than the observed value, while by applying the topographic effect alone the computed value is larger than the observed one. The writer favors the view that the cause is abnormally heavy rock in the upper crust just below the island, but no definite conclusions should be drawn until we shall have accurate topographic maps of the island and charts of the extensive water areas to the north and south of the island. When they are available a revised computation will be made.

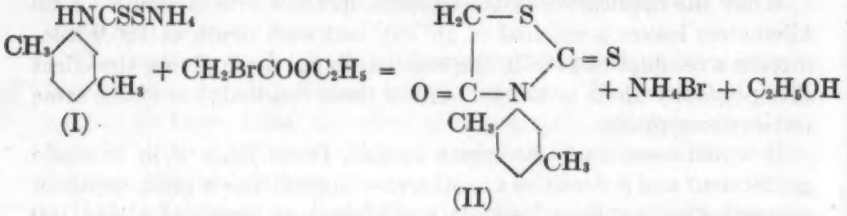
CHEMISTRY.—*2-thio-3-(2-p-xylidyl)-4-keto thiazolidone and some of its derivatives.*[1] RAYMOND M. HANN, George Washington University. (Communicated by Edgar T. Wherry.)

In previous papers of this series the reactions of 2-thio-3-aryl-4-thiazolidones (rhodanic acids) with isatin[2] and with halogen substituted 3-methoxy-4-hydroxy benzaldehydes[3] have been reported. During the course of the above mentioned investigations several new thiazolidones were prepared in pure condition and the purpose of the present paper is to record the preparation and properties of 2-thio-3-(2-p-xylidyl)-4-thiazolidone and some of its derivatives.

The synthesis of 2-thio-4-thiazolidones, commonly known as rhodanic acids, and in reality the anhydrides of di-thio carbamo thio glycollic acids, is easily effected through the interaction of the ammonium salt of a substituted dithiocarbamic acid with an α-halogen substituted monocarboxylic acid. In the present instance ammonium

[1] Contribution from the Chemical Laboratory of the George Washington University.
[2] Hann, Journ. Am. Chem. Soc. 47: 1189. 1925.
[3] Hann, Journ. Am. Chem. Soc. 47: 1998. 1925.

2-p-xylidyl dithiocarbamate (I) was allowed to react with brom acetic ester, when ammonium bromide and ethyl alcohol were eliminated with subsequent ring closure to form the 2-p-xylidyl thio thiazolidone (II).



(I) (II)

Attention has previously been called to the marked activity of the methylene hydrogen of keto thiazolidines due to the CO-CH_2-S linkage. In common with other members of the series the 2-p-xylidyl homologue reacts readily with aldehydes to given beautiful crystalline derivatives which act as weak yellow dyes. These compounds are insoluble in water, but dissolve in concentrated sulphuric acid with the production of brilliant red colors. In this paper are described the benzilidene, cinnamilidene, vanillidene, 5-brom vanillidene and dibrom phenyl proprionilidene derivatives.

Experimental

Ammonium-2-p-xylidyl dithiocarbamate.—Forty-five grams of 2-p-xylidine[4] (boiling point 215.4°C.), 60 cc. of strong ammonium hydroxide and 30 grams of carbon disulfide were mixed. Upon vigorous agitation the mixture gradually warmed up and finally resulted in a clear red oil. Upon standing overnight some slight separation of a yellow crystalline material had taken place. This was crushed and the now viscous solution thoroughly stirred and placed in cold storage room (−10°C.) for 24 hours. At the end of this period of time an abundant separation of the desired salt had occurred. This was filtered off by suction and dried on the filter. The yield amounted to 58 grams which is approximately 80 per cent of that required by theory.

Ammonium 2-p-xylidyl dithiocarbamate is a slightly yellow crystalline solid, possessing a marked somewhat disagreeable odor. It is soluble in water and alcohol, but can not be recrystallized from these solvents due to decomposition. Upon standing in the air it gradually decomposes, yielding a yellow oil.

2-thio-3-(2-p-xylidyl)-4-keto thiazolidine.—Fifty-eight grams of ammonium 2-p-xylidyl dithiocarbamate was suspended in 50 cc. of absolute ethyl alcohol and to the suspension 45 grams of mono brom

[4] The 2-p-xylidine was prepared by J. F. T. Berliner of the Graduate School of the George Washington University.

ethyl acetate rapidly added. An exothermic reaction took place at once and the flask containing the reaction mixture was placed under a reflux condenser to prevent loss of its volatile constituents. Ammonium bromide separated and the flask contents boiled vigorously. When the violence of the original reaction had somewhat abated, heat was applied and the suspension gently refluxed for a period of five hours. After standing overnight, an excess of water was added, causing the separation of a heavy yellow oil. This oil was washed thoroughly with water to remove ammonium salts, then with sodium carbonate solution and finally again with water. Upon standing for a week a considerable portion had solidified. The solid portion was filtered off and the residual oil worked up for more of the reaction product. The total yield was 44 grams, which is 70 per cent of theory.

Thio-3-(2-p-xylidyl)-4-keto-thiazolidine is a yellow crystalline solid, readily soluble in acetic acid and alcohol, practically insoluble in water. When heated in a capillary tube it melts at 119–20° C. (corrected) to a clear light yellow oil.

Analysis: 0.1040 gram consumed 4.4 cc. $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold method) = 5.93 per cent N. Theory for $C_{11}H_{11}ONS_2$ = 5.91 per cent N.

2-thio-3-(2-p-xylidyl)-5-benzal-4-thiazolidone.—Three grams of 2-thio-3-(2-p-xylidyl)-4-thiazolidone, 1.5 grams of benzaldehyde and 5 grams of fused sodium acetate were refluxed with 25 cc. of glacial acetic acid for 2½ hours. After cooling an excess of water was added and the precipitated condensation product was filtered by suction and recrystallized twice from glacial acetic acid. The yield was quantitative.

The 2-thio-3-(2-p-xylidyl)-5-benzal-4-thiazolidone is a brilliant yellow crystalline compound, readily soluble in hot glacial acetic acid and only sparingly so in cold. The compound dissolves in concentrated H_2SO_4 with production of a brilliant red color. When heated slowly in a capillary tube it melts at 188–9°C. (corrected) to a clear yellow oil.

Analysis: 0.1061 gram consumed 3.2 cc. $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold method) = 4.22 per cent N. Theory for $C_{18}H_{15}ONS_2$ = 4.31 per cent N.

2-thio-3-(2-p-xylidyl)-5-cinnamal-4-thiazolidone.—Three grams of the xylidyl cyclic ketone, 1.7 grams of cinnamic aldehyde, 5 grams of fused sodium acetate and 25 cc. of glacial acetic acid were refluxed for about

an hour. The condensation product separated after 10 minutes of heating. After cooling an excess of water was added to the reaction mixture, the precipitated solid was filtered off and recrystallized from 75 cc. of glacial acetic acid. The yield was quantitative.

Thio-3-(2-p-xylidyl)-5-cinnamal-4-thiazolidone is a solid, crystallizing in beautiful brilliant needles of an orange yellow color. It is soluble in glacial acetic acid and insoluble in water. Heated in a capillary tube it melts at 194–5°C. (corrected) to a clear yellow oil.

Analysis: 0.0982 gram consumed 2.8 cc. of $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold method) = 3.99 per cent N. Theory for $C_{20}H_{17}ONS_2$ = 3.99 per cent N.

2-thio-3-(2-p-xylidyl)-5-(α β dibrom-β-phenyl propional)-4-thiazolidone.—The mother liquors from the recrystallization of the cinnamilidene derivative were cooled in an ice salt bath and bromine vapors passed over the solution. An immediate precipitation of an orange yellow solid occurred at the liquid surface. To complete the reaction an excess of bromine dissolved in glacial acetic acid was added. The precipitated solid was filtered by suction and dried, when it was obtained as a yellow brown powder. Upon heating in a capillary tube it melted, after preliminary softening, at 119–20°C. (corrected) with decomposition.

Analysis: 0.1130 gram consumed 2.3 cc. $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold method) = 2.85 per cent N. Theory for $C_{20}H_{17}ONS_2Br_2$ = 2.74 per cent N.

2-thio-3-(2-p-xylidyl)-5-vanillal-4-thiazolidone.—This derivative was prepared by the general method used above, from 3 grams of the thiazolidone and 1 gram of 3-methoxy-4-hydroxy-benzaldehyde.

Thio-3-(2-p-xylidyl)-5-vanillal-4-thiazolidone crystallizes in flower-like clusters of bright yellow needles. It is soluble in hot acetic acid and in alcohol, but insoluble in water. It is also soluble in concentrated sulphuric acid with production of a brilliant red color. It melts at 155–6°C. (corrected) to a clear yellow oil.

Analysis: 0.1137 gram consumed 3.0 cc. $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold method) = 3.69 per cent N. Theory for $C_{19}H_{17}O_2NS_2$ = 3.77 per cent N.

2-thio-3-(2-p-xylidyl)-5-(5-brom-vanillal)-4-thiazolidone.—The condensation of the brom substituted vanillin was carried out in the usual manner. This compound crystallizes in compact masses of golden brown glistening crystals, which yield a bright yellow powder when crushed. The compound dissolves in sulphuric acid with development

of a bright red color. It melts at 192–3° (corrected) to a clear deep yellow oil.

Analysis: 0.1468 gram consumed 3.3 cc. $\frac{N}{10}$ acid (Kjeldahl-Gunning Arnold Method) = 3.15 per cent N. Theory for $C_{19}H_{16}O_3NS_2Br$ = 3.11 per cent N.

SUMMARY

2-thio-3-(2-p-xylidyl)-5-thiazolidone has been synthesised.

Its condensation products with benzaldehyde, cinnamaldehyde, vanillin, 5-brom vanillin and $\alpha\beta$ dibrom β phenyl-propionaldehyde have been prepared and described.

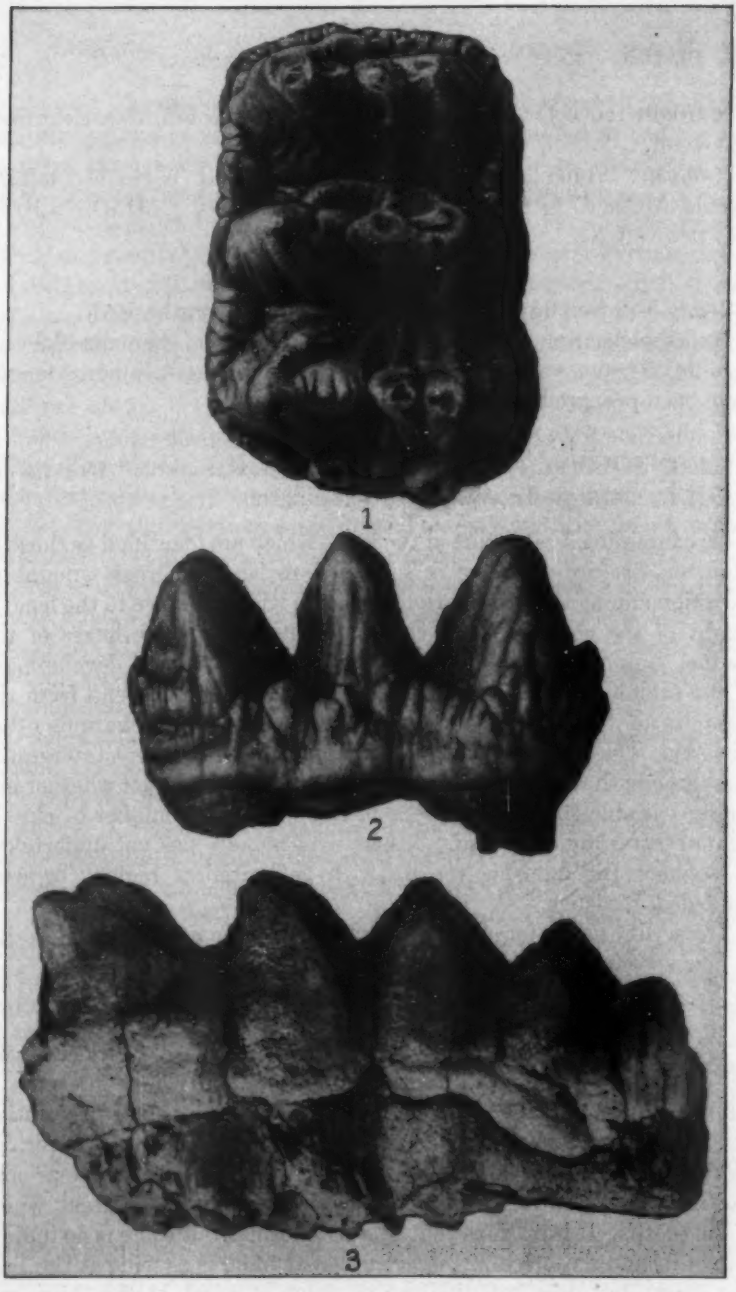
PALEONTOLOGY.—*Two new Pleistocene mastodons.* OLIVER P. HAY, Carnegie Institution of Washington.

On examining a collection of the teeth which are identified as those of *Mammut americanum*, one is surprised to see the great amount of variation among them; variation in size, in width relative to the length, height of the cones of cross-crests, roughness or smoothness of the enamel, number of cross-crests in the hindmost molars, development of the talons, strength of the crests (*cristae*) which descend from the summits of the principal cones into the valleys, and various other features. One is compelled, too, to recognize the frequent intergradations among these various molars; and one is led to wonder whether one highly variable species is represented or whether a number of closely related forms are indicated. Apparently nobody has yet undertaken to connect the differing molars with geographical regions or with geological horizons.

The writer has before him two molars which he ventures to describe as new species.

Mammut francisi, new species (Fig. 3 and 4)

The writer has received for examination, from Dr. Mark Francis, College Station, Texas, a tooth of a mastodon which presents a number of peculiarities and which appears to be worthy of description and a distinctive name. This tooth was found in Brazos River, at Pittbridge, Burleson County. It is the upper right third molar and had not yet begun to wear. One striking feature is the great width of the tooth. It is possible that this is abnormal, but there is no indication of it, and a tooth of *M. americanum* at hand is as wide at the first two crests, but does not diminish so much in width at the third and



Figs. 1 and 2. *Mammut oregonense*. Type. ×0.65+. 1. View of grinding face. 2. View of inner face. Fig. 3. *Mammut francisi*. Type. ×0.71+. View of outer face.

fourth crests. The total length is 147 mm.; the width taken at the first and second cross-crests is 100 mm. At the third and fourth

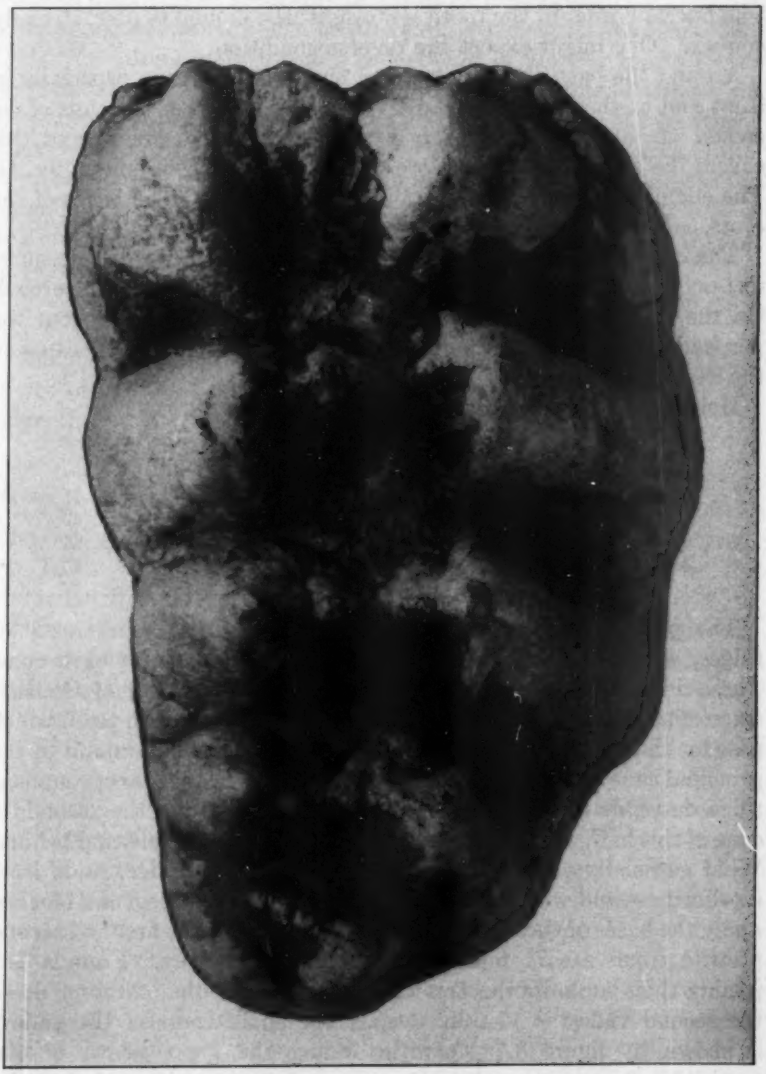


Fig. 4. *Mammut francisi*. Type. × 1. View of grinding face.

cross-crests the width is respectively 86 mm. and 70 mm. It may be said that there is a small fifth crest, only the pretrite portion of which is developed. Behind this is what may be regarded as a small talon. The buccal border of the tooth is straight; the lingual border, strongly convex. One might expect the reverse condition.

Around the base of the crown is a cingulum, showing especially in front and at the ends of the valleys, small on most of the ends of the crests. In all of the valleys is a thick deposit of cement, and this covers the slopes of the cross-crests almost to their summits, (fig. 4). The enamel is white; the cement is stained brown. The bases of the roots, as seen in figure 3, are covered with cement.

The crown is of moderate height. The following are the measurements of the cones taken along the slopes from the base of the crown. On the posttrite side these measurements differ but little from the perpendicular height; on the pretrite side they are greater, because of the lesser slope.

Heights of cones of cross-crests are as follows:

Posttrite	mm.	Pretrite	mm.
1	57	1	71
2	56	2	67
3	50	3	65
4	47	4	55
		5	57

The pretrite cones possess conspicuous front and rear crests, or ridges, which descend into the valleys from the apex of each cone. These ridges are exaggerations of those found in most teeth of *Mammut americanum*, but they are in some cases even surpassed in teeth which pass for those of the species last mentioned. From the summit of the principal cone of the posttrite half of the cross-crests, a less prominent ridge descends to the valley on each slope; also from the secondary cone of this half, a feeble ridge or welt is sent down in front and behind. What especially characterizes the tooth from Pittbridge, aside from its shortness and width, is the extent to which the valleys are blocked up by the bases of the cross-crests. The heights of the first and second pretrite cones are 71 mm. and 67 mm. respectively. From a line joining their summits the first valley is not more than 20 mm. deep; the second valley is 15 mm. deep. The shallowness of the valleys is shown by figure 3. Notwithstanding the great width of the tooth the distance apart of the apices of the pretrite and posttrite cones is small, 40 mm., 39 mm., 35 mm., 30 mm., respectively from

the first to the fourth cross-crests. That part of the cross-crests between the principal cones is sharp and the conules usually present in *Mammut americanum* are feebly or not at all developed.

An upper left third molar of *Mammut americanum* (Cat. no. 335, U. S. Nat. Mus.), said to have been found in alluvial banks of the Susquehanna River, is 175 mm. long and 102 mm. wide at the second cross-crest. It has strong descending ridges on the faces of the pretrite cones, weak ones on the cones of the other half of the cross-crests. The whole crown is rough with welts and small knobs. At the ends of the valleys are large conules. On the summit of the posttrite half of each cross-crest is a row of four or five conules; others less distinct on the pretrite side. The cones are high, the second about 73 mm. The valleys, where the descending ridges meet, are 30 mm. from the summits of the cones in the first and second valleys.

Believing that the tooth here described from Pittbridge represents a species of *Mammut* not hitherto recorded and wishing to honor the finder, the writer proposes to call it *Mammut francisi*.

Mammut oregonense, new species (Fig. 1, 2)

In the U. S. National Museum is a mastodon tooth (Cat. no. 4911) which was sent there in November, 1900, by Dr. Waldemar Lindgren, from Baker City, Baker County, Oregon. It had been found by the Cartwright Brothers, placer miners, at Rye Valley, on Dixie Creek, in township 13 south, range 43 east. Dr. Lindgren reported that the tooth had been found in a fluviatile clay bed which had formed a part of a bench of auriferous gravels, overlying the Payette beds. He regarded the fluviatile clay as of Pliocene age. It appears more probable that the bed belonged to the Pleistocene, for in it was discovered a tooth of *Elephas columbi*.

With this tooth came another of *Mammut* (Cat. no. 4912), a well-worn fragment of the rear of M_3 of left side, showing 2 cross-crests, width 68 mm. It may or may not belong to *M. oregonense*. The type tooth here described and figured is the upper left second molar. It has been regarded as belonging to *M. americanum*, but it is so different that the writer ventures to give it a distinct name.

The tooth had apparently not yet begun to suffer wear; or, if at all, only slightly on the first cross-crest. The length is 111 mm.; the width of the front end, 74 mm.; of the rear end, 80 mm. The crown presents 3 cross-crests and, in the rear, a talon. The crests are high, and the valleys narrow. The ends of the cross-crests slope steeply

and nearly equally. The summits of the two principal cones of each crest are well separated, as follows: First crest, 38 mm., second, 40 mm., third, 40 mm.

The heights of the principal cones from the base of the crown are as follows:

Pretrite	mm.	Posttrite	mm.
1	55	1	43
2	58	2	48
3	58	3	52

On the front and rear faces of the main pretrite cones strong ridges, or crests, run down into the valleys, but where they meet they block the valley but little, inasmuch as they flatten and subside. The first and second valleys are 30 mm. deep below a line spanning the summits of the pretrite cones. On the posttrite side narrower ridges descend into the valleys from the summits of both the main and the secondary cones. Besides these ridges, stronger or feebler welts occupy the sides of the cones.

All around the tooth is a heavy cingulum composed, at the pretrite ends of the valleys, of 5 or 6 tooth-like conules. On the posttrite side the conules are smaller and more numerous. At the front and rear ends the cingulum is more bead-like. At the rear, in front of and above the cingulum, is the talon composed of 3 large conules, of which the inner one has an elongated, the middle one a triangular, the outer one an elliptical base.

In his work on mastodons, Dr. Günther Schlesinger,[1] in an endeavor to show that *Mastodon tapiroides* belongs, not in the bunodont, but in the zygolophodont series, calls attention to the crests which descend from the summits of the cones on the posttrite ends of the cross-crests of the zygolophodont mastodons. On his page 160 he presents the characters which distinguish *M. tapiroides* from the bunodont type, as represented by *M. angustidens* (= *Gomphotherium leptodon*). On his page 174 he goes on to say that in addition to all those characters there is another which excludes from the bunodont type not only *M. tapiroides*, but all of the zygolophodonts. This is the presence of those *cristae*, or crests, which are found on the slopes of the principal and the secondary cones of the posttrite end of the cross-crests. Among the bunodonts he affirms they are never present. The present writer regards this statement as an error. These crests are found especially

[1] *Die Mastodonten*, etc. Denkschr. nat.-hist. Staatsmus. 1. 1921.

well developed on the posttrite ends of the cross-crests of *Gomphotherium* (*Mastodon*) *floridanum;* and distinct traces at least, of these crests are seen in other bunodont species, even in upper molars of *G. leptodon.*

RADIOTELEGRAPHY.—*The present status of radio atmospheric disturbances.*[1] L. W. AUSTIN, Laboratory for Special Radio Transmission Research.[2]

Our knowledge concerning the atmospheric disturbances is still very meager. The observed facts may be cataloged as follows: (1) In general, atmospherics are stronger at the longer wave lengths. (2) Except for the effects of local storms, they are nearly always stronger in the afternoon and night, while for the higher frequencies this increase in strength is confined usually to the night alone. (3) They are stronger in summer than in winter, (4) in the south than in the north, and (5) on the land than on the ocean. (6) A large proportion of them appear to be directive; that is, to come from definite regions, or centers, as mountain ranges, rain areas, or thunderstorms. It is also reasonably certain that (7) at least most of the long-wave disturbances travel along the earth with a practically vertical wave front,[3] like the signals; (8) that a considerable portion are oscillatory in character, though a certain portion are non-oscillatory and give rise to shock oscillations in the antenna at all wave lengths; and (9) that disturbances sometimes occur simultaneously at stations thousands of miles apart.[4]

The origin of the ordinary rumbling disturbances (grinders) has been the subject of many conjectures. Eccles[5] believed at one time that he had found the source of this type of disturbance, as far as England was concerned, in distant thunderstorms, especially in Western Africa. DeGroot[6] has suggested that the grinders are due to the bombardment of the upper atmosphere by electrons from the sun or

[1] Presented at the annual meeting of the Section of Terrestrial Magnetism and Electricity of the American Geophysical Union, Washington, D. C., April 30, 1925. Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] Conducted jointly by the Bureau of Standards and the American Section of the International Union of Scientific Radio Telegraphy.

[3] This JOURNAL, **11**: 101. 1921.

[4] M. Baumler, Jahrb. d. Drahtlosen Teleg., **19**: 325. 1922. This matter of simultaneous crashes needs further investigation since a certain number of such coincidences may evidently occur by chance.

[5] Electrician (London), **69**: 75. 1912.

[6] Proc. I. R. E. **5**: 75. 1917.

charged cosmic dust. The idea that this type of disturbance comes in some way from above has also been held by Weagant.[7] Mosler,[8] while ascribing the disturbances to thunderstorms, concluded in contradiction to the ideas of Eccles, that thunderstorms could give rise to atmospherics only over a radius of about 60 miles. This limitation in distance was very probably due to insensitive apparatus. A very systematic study of thunderstorms and atmospherics, undertaken by the British Meteorological Office and the Admiralty, has apparently settled the fact that thunderstorms can be located with modern apparatus up to about 1500 miles.[9]

There is still much difference of opinion as to the proportion of atmospherics which is due to thunderstorms. Professor Appleton, at a symposium[10] on atmospheric ionization and radiotelegraphy, November 28, 1924, expressed the opinion that practically all atmospheric disturbances might be produced by thunderstorms somewhere in the world.

It is undoubtedly true that thunderstorms produce many atmospherics, but it is not by any means certain that the lightning flashes themselves are always the actual sources. There is a widely prevailing idea among radio operators that the lightning flash often produces only a harmless click in the telephone receivers. I have made some observations during thunderstorms, using a coupled circuit with rectifying vacuum tube and galvanometer, which indicated that lightning flashes, even within three or four miles, were not as powerful in their effects on the receiving apparatus as many of the disturbances which occurred when no flashes were apparent. This comparatively feeble effect of the flashes is difficult to understand if the current rise at the beginning of the flash is as steep as is often assumed but would be understandable if the lightning discharge curves were of the form and duration of the atmospheric disturbance curves observed by Appleton and Watt (figs. 1–5). On the other hand, it is quite possible that the small deflections from the lightning flashes were due to a paralysis of the detector tube, a phenomenon which often occurs when the tube is exposed to very high electromotive forces. It must, therefore, be concluded that the connection between lightning and atmospherics is still not clear, and valuable work can be done by anyone who will watch the lightning and listen to the atmospheric crashes from thunderstorms in the neighborhood.

[7] Proc. I. R. E. **7**: 207. 1919.
[8] Elektrot. Zeits. 1134. 1912.
[9] World Power, **3**: 20. 1925.
[10] Proc. Phys. Soc., London, **37**: 2D–50D (appendix). 1925.

At the London Physical Society symposium already mentioned, Professor C. T. R. Wilson discussed the probability of there being discharges of thunderclouds to the upper conducting region of the atmosphere. His calculations indicated that thunderclouds of common electric moment might very readily discharge to a conducting layer at a height of 60 or 80 kilometers, since the electric force required to produce discharge decreases even more rapidly with the height than the electric force of the thundercloud. Discharges of this kind, probably non-luminous, may possibly furnish the explanation of the strong atmospherics heard from thunderclouds when no flashes are visible.

Mr. Watson Watt, in analyzing the records of European[11] direction-finding stations, concluded that in only about 35 per cent of the cases could thunderstorms be identified as the sources of atmospheric disturbances, though in about 75 per cent of the cases the indentified sources were rain areas of some kind.

Captain Bureau[12] of the French Meteorological Office has recently published papers in which he shows that many of the atmospheric disturbances in France are closely connected with the advance of meteorological cold fronts and that the atmospherics are accentuated when these air movements come in contact with mountain ranges.

For the determination of the direction from which atmospheric disturbances come, Mr. Watt[13] has invented an automatic recording apparatus in which a radio compass coil, tuned to about 30,000 meters, is rotated slowly and continuously by clockwork, the atmospheric crashes being recorded on a drum attached to the coil.

It should be said in this connection that it has been very common in Europe to estimate the strength of atmospherics by the number of disturbances occurring in a given time. This method, of course, would hardly seem to be applicable to our Washington summer conditions, or to the conditions during the disturbance season in the tropics where often in the afternoons and evenings the noise in the telephones forms an almost continuous rumbling through which no signal can be heard unless it is strong enough to rise above the background of disturbing sounds.

If, indeed, there is a physical difference between the atmospherics, crashes, grinders, etc., it is not at all certain that what is being measured in Europe by the counting method is the same thing that is being measured in America, either by direct estimates of the average dis-

[11] Nature, 110: 680. 1922.

[12] C.-R. Acad. Sci. 176: 556 and 1623. 1924; L'Onde Electrique 3: 385. 1924.

[13] Proc. Roy. Soc., A, 102: 460. 1923. Phil. Mag. 45: 1010. 1923.

turbance strength, or by measuring the strength of signal which can be read through the disturbances.

On the Atlantic and Pacific coasts of the United States, except for occasional local thunderstorms, very little certain connection has been noticed between the direction of the atmospheric disturbances and rain areas. On the Atlantic Coast, the main disturbances seem to come roughly from the southwest, but it seems uncertain whether the sources are in the Allegheny Mountains or much farther removed, perhaps in Yucatan. Experiments reported by the Navy Department in New Orleans have indicated the more southerly origin.

Unfortunately, very few triangulation experiments have been made in America for fixing the exact positions of sources of atmospherics. In most cases, therefore, the direction is all that is known.

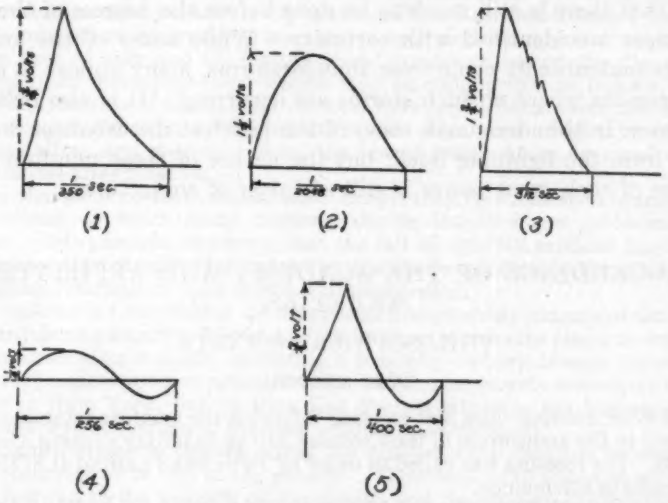
Observations made at Madison, Wisconsin, by Professor Terry of the University of Wisconsin, covering the last two years, show conditions in the Middle West which are similar to those described by the continental European observers; that is, there is no single prevailing direction of the atmospherics, but a more or less definite connection with thunderstorms and other rain areas. This absence of any prevailing southerly source of atmospherics in the central portion of the country casts doubt on the Mexican origin of those observed in the Atlantic Coast region, since the distance from Yucatan to Madison, Wisconsin, is about the same as from Yucatan to Washington.

On the Pacific Coast of the United States it is pretty well established that at least at San Francisco and San Diego the sources of disturbances are largely local, lying in the mountain ranges not far from the coast. These centers seem to be permanently fixed, resulting in very constant directional conditions.

It seems to be pretty well settled, in all parts of the world where observations have been made, that there is a very definite connection between the intensity of the disturbances and the position of the sun. In the northern hemisphere during the winter when the sun is far in the south, the disturbances are generally moderate even as far south as Panama, within 9° of the equator. But as the sun comes north in the spring, there is often a rapid and, sometimes, very sudden increase in strength, and it is reported that stations close to the equator experience two disturbance maxima, corresponding to the two periods when the sun is nearly overhead.

In addition to the study of the sources of the disturbances, the question of their wave form is of much importance. Messrs. Watt and

Appleton[14] in England, working under the Radio Research Board, have made some investigations of this problem, making use of the cathode-ray oscillograph (Braun tube). In their work the atmospheric disturbance, after being received on an aperiodic antenna and amplified by an aperiodic resistance-coupled amplifier, was impressed on one pair of plates of the oscillograph, while a source of 60-cycle current was connected to the other pair of plates for the purpose of drawing out the spot of light into a line on the fluorescent screen. The resulting movement of the spot of light could not be photographed, but could



Figs. 1, 2, 3, 4 and 5. Atmospheric disturbance curves observed by Appleton and Watt

be observed and sketched with some accuracy. Five typical curves are shown in the figures. Most of these appear to be aperiodic, though some are feebly oscillatory.

In figure 3 it is seen that there are minute oscillations superposed on the main curve. It will be noted that the period of the main oscillation is, in all cases, of audio frequency; and Eckersley[15] has pointed out recently that the relatively prolonged impulses of Watt and Appleton can not account for the observed intensity of the atmospherics

[14] Proc. Roy. Soc., A, 103: 84. 1923.
[15] Electrician (London), 93: 150. 1924.

ordinarily experienced in radio reception. He suggests that possibly the ripples, such as are shown in figure 3, may be the actual atmospheric waves. Mr. Watt in the symposium cited accepts this view and adds that more recent experiments in Egypt and elsewhere in the tropics show that there the fine ripple structure is much more common and of much greater amplitude than in England. Professor Appleton, on the other hand, holds that the low-frequency wave forms shown in the figures are capable of producing the observed disturbances at all wave lengths by shock excitation.

In conclusion, the differences of opinion mentioned in this paper show that there is still much to be done before the sources of the disturbances are identified with certainty. While many of the atmospherics undoubtedly come from thunderstorms, many appear to come from regions where no such storms are occurring. It is also believed that even in thunderstorms some of the heaviest disturbances do not come from the lightning itself, but the nature of these non-luminous sources of such great power is still a matter of conjecture.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

923D MEETING

The 923d meeting—the first meeting following the summer intermission—was held in the auditorium of the Cosmos Club on Saturday evening, October 3, 1925. The meeting was called to order by President FLEMING at 8:15 with 33 persons in attendance.

Program: S. P. FERGUSSON. *Meteorology of the total solar eclipse of January 24, 1925.* (Illustrated by lantern slides). The circumstances of the total eclipse of January, 1925 were, in one respect, most favorable for the study of the very small, temporary disturbance of the atmosphere caused by the shadow. The path crossed a region abounding in easily-accessible sites for observing-stations and instruments capable of indicating the small changes of condition to be expected were available at several observatories in and near the path. On the unfavorable side, even near the coast of Connecticut and Rhode Island, totality occurred only two hours after sunrise, the altitude of the sun was below 20°, and the probabilities were that the effects would be small, at best, and negligible west of the 75th meridian. Furthermore, in January, in this region, the variability of the weather and its storminess attains the annual maximum—conditions likely to obscure the small effect probable.

Through the courtesy of W. G. FOYE of Wesleyan University, in providing facilities for the exposure of instruments during the eclipse, the author obtained continuous records of atmospheric pressure and the direction of the

wind, observations of the kind, direction, velocity, position, and density of clouds and attempted the measurement of shadow-bands. The wide scales of the automatic instruments permitted readings of pressure to 0.03 millibar and of the direction of the wind to 2° of azimuth, at intervals of two minutes. The observations of clouds were made at irregular intervals, usually of three to seven minutes. To these data have been added observations of temperature with an Assmann psychrometer at Wesleyan, records from Draper anemoscopes at Central Park, New York, and Blue Hill Observatory, Massachusetts, and observations of temperature and wind at New London, Connecticut, and Westerly, Rhode Island, for which, respectively, the author is indebted to W. I. MILHAM, J. H. SCARR, ALEXANDER MCADIE and C. F. BROOKS.

The weather on the day of the eclipse was unusually favorable for all observations, but very uncomfortable; a severe cold wave prevailed and the temperature ranged between −25° and −15°C. The data referred to have been compared with normals or averages of each element (1) for all conditions at the time of year and (2) for the conditions prevailing on the day of the eclipse. The more important results may be summarized as follows: The fall of temperature of 1°.9C. (slightly more than one half that occurring during average conditions) did not begin until within 30 minutes of totality and the rate of fall at first was very slow; the lowest temperature occurred about ten minutes after totality.

The change of pressure was so small that it may be submerged in irregular fluctuations, of which many occurred during the 12 hours preceding the eclipse. It is possible, however, that the fall of only 0.4 millibar beginning 30 minutes after totality was caused by the shadow, for, under the conditions prevailing, retardation of all effects is to be expected.

At stations in Connecticut the usual calm and irregular changes of the wind occurred during totality, followed by an increase of velocity and a reversal of the direction after totality, indicating a tendency to blow toward the region of lowest temperature and pressure. Similar tendencies were noticeable in the record at New York, but at Blue Hill the velocity was too high and too variable for the detection of the very small eclipse-effect.

A slight decrease in the amount of the alto-cumulus clouds is believed by some observers to be due to the shadow. There was a fall followed by a decided increase in the velocity of the clouds, and the changes of direction indicated a tendency of the air at their level (estimated at 2000 metres above sea-level) to move toward the region of lowest pressure; these results confirm the first observations of this effect during the eclipse of May, 1918.

The shadow-bands, on first appearance, were a mass of fine, bright lines in rapid irregular motion lengthwise as well as laterally; on second appearance the bands were more definitely outlined, but in both instances precise measurements were impossible. There was a general movement, nearly parallel to the path of the shadow, at a rate of between one and two meters a second.

Observations, accumulated mostly since 1900, indicate that these bands probably occur chiefly, perhaps only, during the mixing of masses of air having different densities or temperatures, the necessary contrasts of density being maintained to an appreciable degree only during the rapid decrease and increase of temperature immediately before and following totality. The general movement or drift of the bands appears to be more closely related to that of the eclipse-wind than to the natural wind prevailing at any level. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. PAWLING, CURTIS, HUMPHREYS, and PRIEST.

C. MOON: *A method of comparing the relative frequencies of a tuning fork and a pendulum.* (Illustrated by lantern slides.) An experimental arrangement was described for measuring the relative frequencies of a tuning fork and a pendulum by the well-known method of coincidences. The frequency of the fork must be very near an exact multiple of that of the pendulum.

A series of flashes of twice the frequency of the fork is obtained by the device used by CURTIS and DUNCAN. The light from the slit in the vanes carried by the prongs of the fork is reflected directly into a telescope by two mirrors placed side by side, one attached directly to the pendulum and the other to the pendulum support. The flash images of the slit from the fixed mirror appear superposed at the same place in the telescopic field, those from the moving mirror being separated into a series of lines which appear in the field at each forward and backward swing of the pendulum. For convenience a crude auxiliary pendulum is used to intercept the light source during the backward swing of the pendulum, so that only one series of images are seen for each complete oscillation of the standard pendulum. If the fork frequency is an exact multiple, say N times that of the pendulum, then the image of the first flash, the $(2N + 1)$th, the $(4N + 1)$th . . . . etc., will always appear at the same place in the telescopic field. Since the multiple relation will not be exactly fulfilled, there will be a slight progression of successive images and at regular intervals coincidences will occur between one of the lines from the moving mirror and the line from the fixed mirror.

The time interval between two successive coincidences can be measured with a stop watch. It represents the time required for the fork to gain or lose one-half of a vibration on the pendulum. This interval known, the relative frequencies can be readily computed.

The method has been applied to a 100-cycle fork driven by a vacuum tube and a standard Coast Survey gravity pendulum. With the fork adjusted so that coincidences occurred at about 20 second intervals, the time of a single coincidence may be measured with an error of 5 per cent. This causes an error of approximately one part in 100,000 in the relative frequencies. By measuring five consecutive coincidences, the error can be reduced to two parts per million. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. SWICK, HUMPHREYS, CURTIS, HEYL and PRIEST.

924TH MEETING

The 924th meeting was held in the auditorium of the Cosmos Club on Saturday evening, October 17, 1925. The meeting was called to order by President FLEMING at 8:16 with 55 persons in attendance.

Program: L. B. TUCKERMAN. *We see things which are not there.* (Illustrated by lantern slides.)

If the carbon copy of a typewritten sheet is placed in register over the original and then rotated slightly, a series of concentric circles is seen. When the carbon copy is displaced vertically the circles shift horizontally, the center of the circles always lying at the point of coincidence of the two copies. This effect must have been seen many times, but only one stenographer was found who has recognized the character of the pattern seen. Similar results are obtained from any irregular pattern. An example is a doubly printed photograph, the negative being slightly rotated between the two exposures. An-

other example is a trail photograph of circumpolar stars. The phenomenon is familiar to astronomers who match star photographs in detecting comets or asteroids or in determining proper motion of stars. The illusion is caused by the fact that in looking at objects we mentally complete the patterns which are suggested by the geometrical arrangement presented. A multitude of similar illusions are known and are effectively used by artists. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HEYL, STIMSON, STOKLEY, PRIEST and FERGUSSON.

PHILIP P. QUAYLE: *Single spark photography and its application to some problems in ballistics.* (Illustrated by lantern slides.) An apparatus was described for obtaining shadow pictures of objects in rapid motion by a properly timed illuminating spark. The general principle involved is not new but the means for carrying it out are believed to be unique and considerably more effective than any hitherto described. The apparatus is so arranged that the illuminating spark occurs when the object to be photographed is between it and the photographic plate. There results an ordinary shadow of opaque objects, such as bullets, and inhomogeneities due to sound waves and turbulence of the air give distinctive patterns owing to refraction effects. In the illustrative photographs presented are to be found some striking sound wave phenomena.

The photographs were presented primarily to illustrate the usefulness of the method but they give interesting and important information concerning the gas leakage in a revolver, the acceleration of projectiles outside the muzzle, the so-called stringing effect in shot shells and many other phenomena attending the discharge of firearms. Other characteristics of the photographs were pointed out and in part explained. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HEYL, LAPORTE, HAWKESWORTH, BREIT, TUCKERMAN, WRIGHT and others.

925TH MEETING

The 925th meeting was held in the auditorium of the Cosmos Club on Saturday evening, October 31, 1925. The meeting was called to order by President FLEMING at 8:17 with 33 persons in attendance.

Program: N. E. DORSEY: *A thunderbolt and its results.* (Illustrated by lantern slides.) The nature of the damage which was done when lightning struck a tulip tree was described, and the more interesting features were illustrated by lantern slides. The tree was an interior one of a small, isolated group surrounding the frame church at Annapolis Junction, Md. In the group were several others of the same kind and of the same height (47 feet) as that struck. The most exposed of the tulip trees is about 55 feet high, and the tower of the church is 56 feet high and only 30 feet from the tree which was struck. Neither of these were damaged in the least. Furthermore, the tree was struck within nine feet of the ground. A segment on the northwest side of the tree was splintered, and sections were torn from it; the larger, unsplintered portion of the trunk was split and bowed apart; the blazed area extended only to a height of 27 feet, and the split extended only a short distance higher. Above that, the trunk was undamaged; the lower thirty inches of the trunk was not split. On a large section torn from the tree was a limb of which the overgrown portion had been broken squarely across the grain, and had been pulled from the trunk as a tenon might be pulled from a mortise. This break could have been produced only by a longitudinal pull. Along the

western edge of the splintered segment, and, as nearly as could be determined, in the plane bounding the splintered segment, were four small isolated holes burned through the bark. The hole next to the top extended into the wood for about two inches; and for most of its length it was about the size of the lead of a pencil. The topmost and largest hole was eight feet from the ground; the wood around it was badly torn, and much of it was lost. These four holes mark the spots in which the tree was struck; they pass straight through the sap-wood, which was not seriously damaged. The plane defined by them passes between, and close to, two trees exactly similar to the one struck. Everything indicates that the path of the stroke was essentially uninfluenced by the local field near the ground. The stroke appears to have been of the nature of a free electrical charge travelling, under its own momentum, along a line determined by conditions in the clouds. It was suggested that such a stroke may be closely akin to, and perhaps may actually be, an intense, concentrated beam of cathode rays. It was pointed out that the production of such a beam is not inconsistent with what we know of the conditions in a thundercloud and it was shown that such a suggestion serves to correlate in a logical manner all the prominent effects observed. That the suggestion involves assumptions of which the validity can not at present be demonstrated, was admitted. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. WHITE, HUMPHREYS, PAWLING, BOWIE, and others.

ROBERT H. GAULT: *Touch as a substitute for hearing in the interpretation and control of speech.* (Illustrated by a chart.) This is a report of psychological experiments that are being conducted in Washington under the auspices of the National Research Council. The problem is to determine (1) whether tactual sensation can be made a sufficiently fine means of discrimination to enable one to distinguish the forms of speech and to interpret them, and (2) whether tactual sensation can be successfully employed as sufficient cues to aid in the control of speech—particularly the speech of semi-mutes.

The author employs for his purpose a telephone-like instrument and an amplifier. Each observer (fifteen approximately totally deaf persons) holds a receiver of the instrument in his hand. As many as six sit as observers simultaneously. Each one can feel the words of the experimenter upon the palm of his hand or upon a finger tip, depending upon how the receiver is held. Theoretically no two words feel alike and no two sentences feel alike.

Charts are presented showing the progress of learning sentences, vowel qualities and isolated words. The most successful subjects, working from October 8, 1924, to November 25, 1924, became able to identify, with over 90 per cent of complete accuracy, ten sentences of six monosyllabic words each. They practiced but 25 minutes daily, five days each week. Subsequently the same subjects in the course of three weeks attained a like degree of accuracy in identifying the long vowels. From June 11 to July 8, 1925, four observers, practicing three half-hour periods daily, five days weekly, attained a fair degree of accuracy in identifying 58 words.

In the course of this period selections from the 58 words were employed from day to day to form new sentences that had never before been felt as sentences. The subjects were given an opportunity to interpret the sentences by their feel if they could. One hundred and seventeen such sentences were used in this manner. From the four subjects there were 468 reports; 225 of these were correct word for word; 131 more were correct in sense.

During the summer period referred to, 103 groups of homophonous words

(words that are alike from a lip-reader's point of view, such as "aim, ape") were chosen as stimuli to determine how nicely those of a group could be distinguished by touch. There were groups of two words, three words, etc., up to ten. The members of each group are supposed to *look alike*. As a matter of fact in many instances the members of a group can be distinguished by vision in our experimental situation. Only 50 of the 131 groups are made up of truly homophonous words according to the author's findings. Among the 131 groups there are but seven in which the subjects distinguished better by lip-reading than by touch. In one instance the two methods produced a tie. Ordinarily touch proved to be by far superior to lip-reading in relation to these groups of words.

The author applied the tactual method to the improvement of the voice of a semi-mute. He was made to feel the experimenter's voice upon his hand; thereupon he undertook to reproduce the *feel* by applying his own voice to a transmitter that duplicated the one operated by the experimenter. Thus the subject improved the pitch and syllabication of his words. It was found possible to employ several subjects simultaneously in this experiment. In that situation members of the group criticised their companion who was trying to copy the experimenter's voice. This practice stimulated interest, and furthermore, the subject with the receiver was aided thereby to discover the tactual criteria for vocal control. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. HAWKESWORTH, HUMPHREYS, GIBSON, BOWIE, MERWIN and others. President FLEMING on behalf of the Society thanked Professor GAULT for his interesting paper.

On request by the President, Major BOWIE presented an informal report on the computations of the gravity observations done under a grant from the Society. Five stations in the Southern Pacific were completed and the results will appear in an early issue of the JOURNAL.[1]

926TH MEETING

The 926th meeting was held in the auditorium of the Cosmos Club on Saturday evening, November 14, 1925. The meeting was called to order by President FLEMING at 8:19 with 55 persons in attendance.

Program: L. V. JUDSON: *Geodetic instruments from the viewpoint of the physicist.* (Illustrated by lantern slides.) The instruments particularly referred to are the base line tapes and apparatus for their test; also theodolites and instruments for testing their angular graduations. The design of apparatus used for testing base lines shows striking differences in the different countries. The apparatus used at the Bureau of Standards for testing base-line tapes is both simple and accurate.

The need of extensive investigations in the field of precise graduations of circles was emphasized, and a view of an apparatus for this purpose was shown. It was pointed out that the modern geodetic instrument must embody all the improvements which the physicist can apply, and that fundamental investigations were necessary as a preliminary to advances in design.

As an example of the investigation of 50-meter invar base line tapes which is being carried on at the Bureau of Standards the question of the effect of concentrated loads upon the distance between the terminal graduations of the tape was taken up in some detail. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. BOWIE and HODGSON.

W. L. HUMPHREYS: *An unusual display of mammato-cumulus.* (Illustrated

[1] See this JOURNAL **15**: 445–450. 1925.

by lantern slides.) The mammato-cumulus cloud, also called pocky-cloud, festoon-cloud, sack-cloud, and other more or less descriptive names, is a sheet of cloud with numerous, thick-set, hemispherical pendants. This peculiar feature appears to be the result of an overflowing sheet of potentially cold air, dropping down slightly at numerous places and forming cloud as it goes. This phenomenon is most frequent in connection with thunderstorms, and sometimes is well developed in association with a tornado.

Two pictures were shown of an exceptionally fine example of the mammato-cumulus, obtained at Ashland, Ky., on the afternoon of July 3, 1925, just preceding a heavy but not intense local thunderstorm. (*Author's abstract.*)

Discussion. The paper was discussed by Major BOWIE.

PAUL R. HEYL: *Perpetual motion in the Twentieth Century.* Prior to the recognition of the principle of the conservation of energy it was believed that perpetual motion was impossible, but every proposed device of this character had to be examined on its own merits, and the special reason for its failure to work pointed out. The establishment of the principle of the conservation of energy made this unnecessary; all such devices could be dismissed as violating this general principle.

Very soon the question was raised as to whether there could not be a perpetual motion of a second kind; that is, whether it was not possible under some circumstances for heat to run up hill. MAXWELL showed in the early seventies that the second law of thermodynamics could be set aside by the interposition of intelligence; BOLTZMANN and PLANCK later showed that the basis of the second law was one of probability merely, and that actual departures from this law on a microscopic scale must be expected to occur continually and spontaneously.

In 1900 LIPPMANN suggested two perpetual motion devices based on this principle, and in 1907 SVEDBERG proposed others. In 1912 SMOLUCHOWSKI pointed out a general principle which, as he supposed, rendered these devices inoperative. The speaker showed that SMOLUCHOWSKI was in error in the application of this principle and that the devices of LIPPMANN and of SVEDBERG must be regarded as valid on a molecular scale. (*Author's abstract.*)

Discussion. The paper was discussed by Messrs. DRYDEN, HAWKESWORTH, BREIT, ADAMS, TUCKERMAN and others.

H. A. MARMER, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Petrologists' Club met at the home of F. E. Wright on January 5. H. S. WASHINGTON described the methods now being used in Italy to obtain potassium salts, alum, and pure silica from leucite which is extracted mechanically from certain leucitic lavas in the central Italian volcanic region, There was also a general discussion, led by W. T. SCHALLER and C. S. Ross, on *What is a magma?* From the discussion it appears that current usage of the word is not uniform, the stress being laid by different writers upon such different qualities as (1) high temperature, (2) liquidity, (3) location in a reservoir, (4) action as a source of lava or ore-bearing solutions, (5) possession of dissolved water in various percentages.